Contra Costa County
Flood Control
& Water Conservation District

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June 3, 2009

File: 001-04
Requests for Information

Dear Consulting Engineers:

With increasing requests for our HYDRO6 Program services, it is necessary for you to strictly comply with our requested guidelines for submittals. The attached document provides an outline of the various input data required by the Hydrology Section. These forms have been revised as of June 3, 2009. Notes have been added to help in the computation of most of the parameters. Complete, legible, and true-scale, working hydrology maps must accompany all requests.

For efficiency in responding to your request, all submittals need to be sent to Mark Boucher at:

Contra Costa County Flood Control
& Water Conservation District
255 Glacier Drive
Martinez, CA 94553-4897

These requests should be mailed, sent by courier, or hand delivered. Faxes or e-mails of original requests will be accepted if they are legible and scaleable. Our staff needs to be able to review the input parameters at a measurable scale. Unacceptable submittals will be set aside and the sender will be notified of the need for more legible and/or scaleable documents.

Following these requirements will ensure timely review and checking on our part, thus keeping processing costs down.

If you have any questions, please give me a call at (925) 313-2274

Very truly yours,

Mark E. Boucher

Mark Boucher
Senior Hydrologist
Contra Costa County Flood Control
& Water Conservation District

MB:cw
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Enclosures

c: Greg Connaughton, Flood Control

Fees Charged By The Hydrology Section To Calculate Design Hydrographs Using Hydro6

June 3, 2009

Design flows: $150 per point (1-frequency, 1-duration)
plus
$40 for each additional frequency and duration per point.

Example: Request for 10 and 100-year frequency, 3, 6, and 12-hour durations (six hydrographs) for three watersheds for pre- and post-development conditions:

HYDRO6 Fee Calculator

Project: **Hydrology Study**
Engineering Company: **ABC Engineering**
Date: **12/29/2008**

Area Description	A-Pre	B-Pre	C-Pre	Total
Total Runs/point	6	6	6	18
First Run at $150	$ 150	$ 150	$ 150	
Subsequent Runs at $40	$ 200	$ 200	$ 200	
Total Fee	$ 350	$ 350	$ 350	$ 1,050

Area Description	A-Post	B-Post	C-Post	Total
Total Runs/point	6	6	6	18
First Run at $150	$ 150	$ 150	$ 150	
Subsequent Runs at $40	$ 200	$ 200	$ 200	
Total Fee	$ 350	$ 350	$ 350	$ 1,050

Total Fee	**$ 2,100**

Check can be made out to any of the following:

- Contra Costa County
- Contra Costa County Public Works Dept.
- Contra Costa County Flood Control & Water Conservation District

HYDRO6

Computer Simulation of Rainfall Runoff

HYDRO6 is a computer program developed by the Contra Costa County Flood Control & Water Conservation District (FC District) to compute peak flow rates, runoff volumes, and flood hydrographs for storms of various frequencies and durations in a particular watershed.

A. Input Data

Before the **HYDRO** program can be run, the following information <u>must</u> be supplied. Forms are provided for submittal of items 2 through 10.

1. **Hydrology Map:** A scalable working copy of the watershed boundary map with scale and topography shown. Input parameters of L, and Lca (see below) shall be drawn on the maps as well as the elevations used in calculating the elevation difference. Common engineering scales and USGS[1] map scales are acceptable. (Examples: 1"=100', 1"=40' 1:12,000, 1:24,000, etc.)
2. **Location:** Be specific to watershed, tributary, land-use conditions, etc. (Ex: Tributary to Sand Creek at Deer Valley Road, Existing/Developed Conditions).
3. **Area:** Total watershed area upstream of the point where the flows are being calculated in square miles.
4. **Mean Seasonal Rainfall:** Average seasonal rainfall for the entire watershed.
5. **Storm frequency:** Choice of 2, 5, 10, 25, 50, or 100-year frequencies.
6. **Storm duration:** Choice of 3, 6, 12, 24, or 96-hour duration.
7. **Infiltration rate:** Infiltration rate in inches/hour, averaged for the entire watershed within the watershed boundary for the location. This parameter can be weighted by area.

   $$\Sigma(\text{area}*\text{I})/\Sigma(\text{area})$$

8. **Channel length:** Longest watercourse (flow path) length from watershed boundary to location in miles.
9. **Channel length from centroid:** Length from the perpendicular projection of the centroid on the watercourse to the location in miles.
10. **Elevation difference:** Difference in feet along the longest watercourse from the watershed boundary to the location. This is used in calculating the average slope of the watershed.
11. **N value:** Weighted hydraulic roughness coefficient of the *watershed*; its feeder system weighted by area *not length.*

    $$N=\Sigma(\text{area}*N)/\Sigma(\text{area})$$

12. **Time interval:** The standard is 15 minutes. For very small watersheds (area < 0.2 sq. mi.), a time interval of 5 minutes is used. HYDRO6 can use 3-minute time steps.

[1] USGS = United States Geological Survey

B. Output — The FC District will provide the following output from the HYDRO6 program with:

1. List of input parameters and other hydrologic information calculated by the model.

2. Unit hydrograph.

3. Flood hydrograph with peak flow rate and runoff volume.

C. Suggested procedures for obtaining data (*common mistakes in italics*)

1. Use a topographic map or USGS Quad sheet to draw the watershed boundary and measure the drainage area in mi^2. In general, and as a rule, Contra Costa County does not allow diversions from one watershed to another. Any changes in the drainage patterns should be reviewed for diversions and a clear reason and mitigation for such diversions should be presented.

   Software can be used to delineate the watershed boundaries. We have found several errors in the delineations done by software, and these must be checked thoroughly before calculating the parameters. The pre- and post- development watersheds need to be carefully compared to ensure consistency. The subdivision or project boundary is not the watershed boundary. Areas that are outside the project boundary, but drain to the boundary, must be considered.

2. Show all watershed parameters on the hydrology map. The hydrology map submitted is to be a working copy of sufficient size, scale, and topography to accurately calculate the following parameters: area, longest watercourse extended to the watershed boundary, change in elevation from the watershed boundary to the location along the longest watercourse, and the watershed centroid plotted.

   Generally, there should be two map submittals, one for pre-development and one for post-development conditions. The post-development map should include the proposed land uses, as well as the above parameters.

   Often, there are changes in watershed sub-areas within the total watershed area due to proposed development. All areas need to be accounted for. If there is a change in one area, it should be reflected in change of an adjoining area. The pre- and post- development watersheds need to be carefully compared to ensure consistency. The subdivision or project boundary is not the watershed boundary. Areas that are outside the project boundary, but drain to the boundary must be considered.

   Generally, a faxed map is insufficient. Please mail or drop-off a paper copy with no appreciable scale distortion. A good PDF will be accepted if it can be plotted to true scale.

3. Use Flood Control Drawing B-166 to determine the mean seasonal rainfall for the watershed in inches.

4. Select storm frequency based on drainage area, such as, 10-year for areas less than 1 mi^2, 25-year for areas larger than 1 mi^2 but less than 4 mi^2, and 50- and 100-year for an area larger than 4 mi^2.

5. Select storm duration: Use 3-hour if there is no detention basin involved. Also run 6 and 12-hour duration and 100-year storm if a detention basin is involved.

6. Use Table 1 and the projected future land use to estimate infiltration rate in inches/hour. Use a weighted value if multiple land uses are involved and include calculations with input. $I=\Sigma(\text{area}*I)/\Sigma(\text{area})$

7. Determine the channel length in miles of the longest drainage path (creek, pipe, and overland flow) within the watershed extended to the watershed boundary.

8. Determine the centroid of the watershed.

   To manually determine the centroid of the watershed:

   a. Plot or print the watershed on relatively stiff paper and cut it out.
   b. Pin the cutout loosely to a wall so that it will rotate freely on the pin and come to rest without friction from the pin or from rubbing the wall.
   c. Draw a vertical line from the pinhole down and across the cut out. This can be done by hanging a string from the pin and marking the cutout where the string crosses the bottom of the cutout. A straight line drawn from the pinhole to the mark will go through the centroid of the cutout.
   d. A second line, located and drawn using this technique, will locate the centroid where the lines cross.
   e. A third line drawn using this technique should confirm the centroid location.

   On very small cutouts of stiff paper, balancing the cutout on a pencil tip will also approximate (or check) a centroid.

   The larger the plot used in this technique, the stiffer the paper needs to be. Therefore, plotting or printing the watershed at a small scale is more practical. You must consider, however, how easy odd shapes or details will be to cut out at smaller scales. Stiff cardboard, such as that used to support/protect larger paper bundles, is ideal for large areas that can't be plotted smaller, but is more difficult to cut.

   The centroid can also be determined using CAD[2] program functions or tools.

   The centroid is often incorrectly located. Software can be used to determine the centroid, but a visual and even physical review of the centroid location should be made by a second individual before submitting. We often see incorrect centroid locations even from those determined using software.

9. Determine the Lca.

   Draw a line from the centroid perpendicular to the longest watercourse. At times, a complicated polyline is used for the watercourse in CAD drawings. This polyline may need to be simplified to get the projection you need using CAD. Measure the distance in miles from the projected point to the outlet. Do not include the distance from the centroid to the watercourse.

   This measurement should not be taken from the centroid to the main channel and down the channel to the bottom of the watershed. It should be only the distance along the channel.

[2] CAD = computer aided design

If the main watercourse “wraps” around the centroid and there is more than one possible perpendicular projection, then the Lca can be the numerical average of the distances from the points projected to the longest watercourse to the outlet. Do not include any projections that extend to a portion of the watercourse that is far away from the centroid. The projection of the centroid on the channel should represent a point in the channel where roughly half of the watershed is above the point.

The projection of the centroid to the channel is an approximation of a much more complicated procedure for estimating the time it takes for the center of mass of the rainfall in one hydrograph time step to reach the outlet of the watershed. If there are numerous subwatersheds, you can check the Lca measurement. Measure the length of the Lca from the outlet to points up each tributary. Delineate the watersheds area above the points. See if the combined areas above the points make up approximately half the watershed. A visual comparison of the areas up and downstream of the points should confirm the appropriateness of the Lca.

10. Determine the elevation difference in feet between the highest and lowest points on the watercourse. These will be located on the watershed boundary.

11. Use Table 2 (areas over 200 acres) or Figure 1 (areas less than 200 acres) with the projected future land use and channel condition to estimate the N value. Include calculations with input. $N=\Sigma(area*N)/\Sigma(area)$

    In determining the N value of the longest watercourse, whether using Figure 1 or Table 2, consideration is given to the different composition of the main watercourse (natural channel, concrete pipe or ditch, earth channel, grassy swale, etc.). It is important to estimate the percentage of the total watershed area that different channel compositions are draining. Then, assign an N value to these subareas, using the efficiency of the tributary system to the longest watercourse. As an example, a watershed has 50% of its area draining to a natural channel without improvements; the N value for this portion would be 0.075. The remainder of the watershed is piped with an efficient feeder system, the N value would be 0.025, and the composite N value for the entire watershed would be 0.050.

12. Complete the "Input Data For HYDRO6 Program" sheet and submit along with a hydrology map, calculation sheets, and a check for the processing fee. An incomplete submittal will not be acted upon until all data is received. Call 925-313-2274 or 925-313-2292 for questions about the input parameters and to obtain the processing fee. Further explanations of the above are shown below.

HYDRO6 Program Submittal Checklist
(Include with each submittal)

1. Working Hydrology Maps, Pre-development and Post-development — Maps should include: scale, legible contours, longest watercourse extended to the watershed boundary, centroid plotted and projected to all possible points on the longest watercourse, elevations labeled at longest watercourse's headwater and outlet points, land use and drainage pattern changes on Post-development map). ☐

2. Table of Infiltration and N-Value Computation — List areas of each land use and your estimate of the infiltration rate of each land use from Table 1. Also, include N-value calculations, which should be based on the total area that contributes to the various make-up of the longest watercourse (Natural channel, improved channel, pipe or concrete-lined channel, etc.). Use Table 2 if the total watershed area at your calculation point is greater than 200 acres and Figure 1 for total area less than 200 acres. ☐

3. Complete Input Data Sheet (or equivalent). ☐

4. Check for Processing Fee. ☐

INPUT DATA FOR HYDRO6 PROGRAM

Location: ____

____

Date: ____________________

By: ____________________

Watershed Parameters	Units
Drainage Area	Square miles
Mean Seasonal Rainfall	Inches
Storm Frequency (Circle all that apply to this watershed)	2 5 10 25 50 100 Year
Storm Duration (Circle all that apply to this watershed)	3 6 12 24 96 Hour
Infiltration Rate	Inches/Hour
Channel Length	Miles
Channel Length from Centroid	Miles
Elevation Difference	Feet
N Value	(Dimensionless)
Time Interval (Circle one)	3 5 15 Minutes

Table 1

Watershed Infiltration Rates

Zoning	Watershed Infiltration Rate (In/Hr)
Open	0.17 – 0.18
R-40	0.14 – 0.16
R-20	0.11 – 0.14
R-10	0.08 – 0.11
R-6	0.05 – 0.08
Multi-Residential	0.04 – 0.06
Industrial	0.03 – 0.06
Commercial	0.02 – 0.05

Based on the Impervious Area Study included in the "Report on Impervious Surface Drainage Fee Ordinance," Contra Costa County Flood Control & Water Conservation District, December 1981, revised January 5, 1982.

Table 2

Suggested N-Values for HYDRO6 Program

(For Drainage Areas Larger Than 200 Acres)

Main Channel System	Feeder System Good	Feeder System Poor
Pipe and/or Concrete-Lined Channel	0.020	0.035
Earth Channel	0.030	0.040
Rock-Lined Channel	0.035	0.045
Clear Natural Channel w/ Minor Improvement	0.040	0.055
Natural Channel w/ Minor Improvement	0.050	0.065
Natural Channel w/o Any Improvement	-----	0.075
Poor Natural Channel	-----	0.085

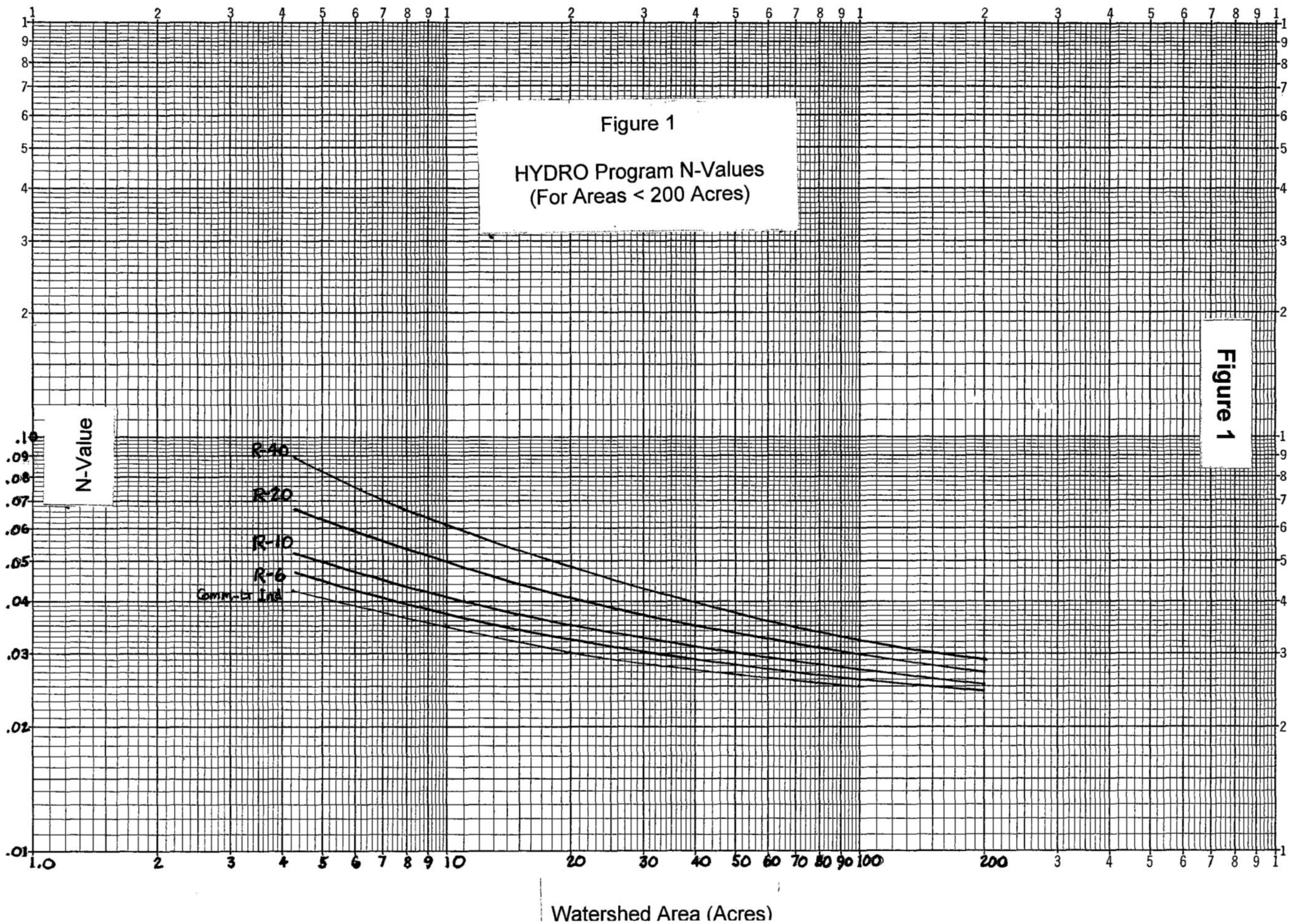


Figure 1
HYDRO Program N-Values
(For Areas < 200 Acres)
N-Value
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
R-40
R-20
R-10
R-6
Comm-Ind
1.0
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
80
90
100
200
Watershed Area (Acres)
Figure 1

(Sample Input)

INPUT DATA FOR HYDRO6 PROGRAM

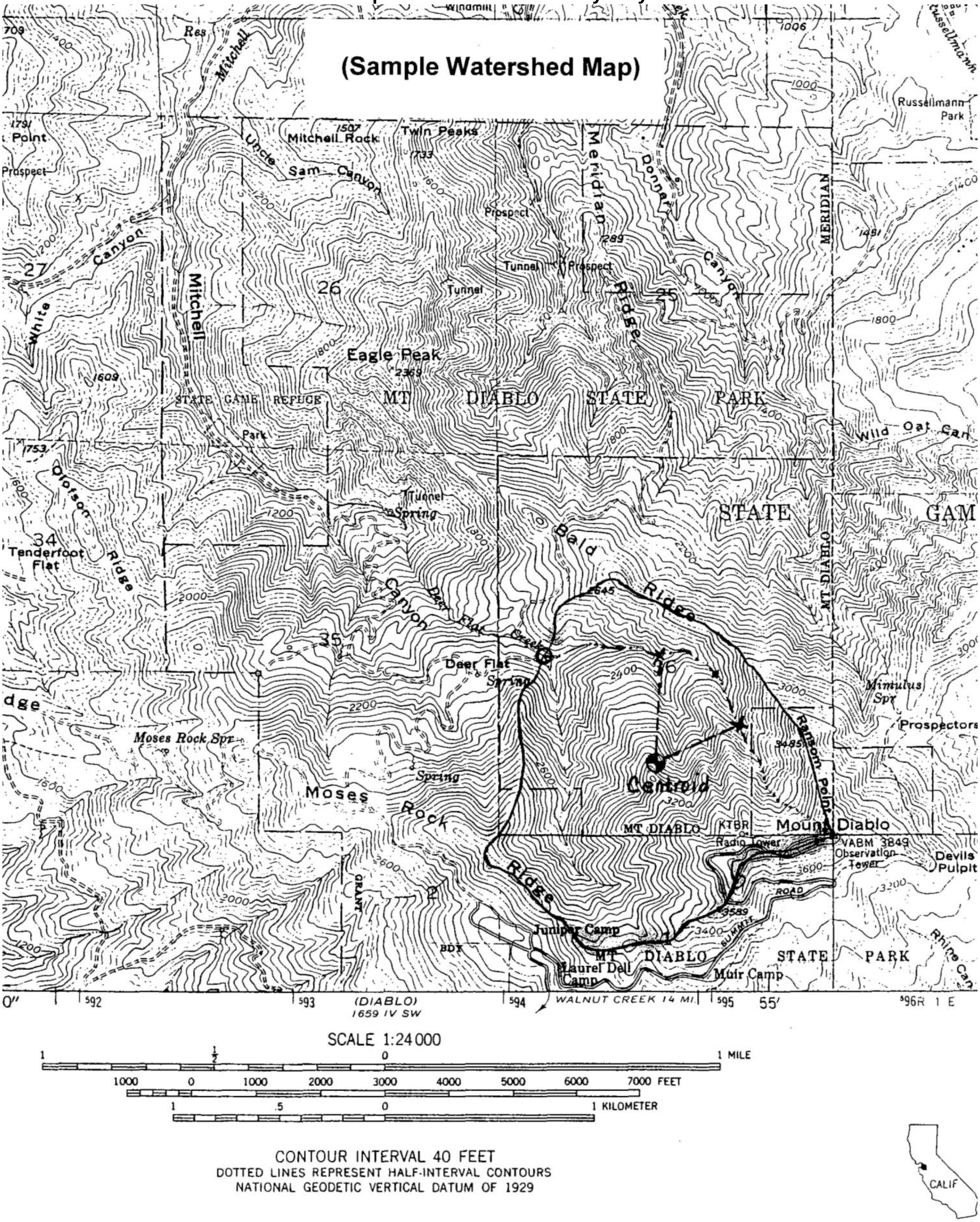
Location: Deer Flat Creek downstream of confluence. About 1-mile NW of Mt._ Diablo Summit.____

Date: March 22, 2000__ _________

By: Mal Weston__ ____________

Watershed Parameters	Units	
Drainage Area	0.71	Square Miles
Mean Seasonal Rainfall	25.0	Inches
Storm Frequency	10.0	Year
Storm Duration	3	Hour
Infiltration Rate	0.17	Inches/Hour
Channel Length	1.16	Miles
Channel Length from Centroid	0.49	Miles
Elevation Difference	1,819	Feet
N Value	0.075	----

Map is scanned – scale may vary



SCALE 1:24 000

1 MILE | 7000 FEET | 1 KILOMETER

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT HALF-INTERVAL CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

(Sample Output)

```
        CONTRA COSTA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT
        -----------------------------------------------------------------
                     255 GLACIER DRIVE, MARTINEZ, CA  94553
                                  925-313-2292

                       *********************************
                       *  EXECUTED  BY  : Mal Weston    *
                       *             TIME: 11:10:35.12   *
                       *             DATE: MAR 22, 2000  *
                       *********************************

**********************************************************************

Deer Flat Creek Downstream of Confluence, 1-Mile NW Mt. Diablo Summit - Current
and Future Conditions

**********************************************************************
 STORM FREQUENCY              10  YR            L            1.16  MI
 STORM DURATION                3  HR            LCA           .49  MI
 WATERSHED AREA             .710  SQ MI         DH          1819.  FT
 MEAN SEASONAL RAINFALL    25.00  IN            N            .075
 AREA-RAINFALL FACTOR       1.00                S-CURVE   WC MTN CURVE
 STORM RAINFALL AMOUNT      1.72  IN            LAG-TIME      .36  HR
 INFILTRATION RATE          .170  IN/HR         C SUB T      1.80


 UNIT HYDROGRAPH *****  NO. OF POINTS =   13     DT =   15.  MIN
 615.    528.    227.    135.     92.     62.     53.     47.     37.

  21.     10.      4.      0.


 FLOOD HYDROGRAPH *****  NO. OF POINTS =   24     DT =   15.  MIN
   4.      4.      4.      4.      4.     30.     59.     89.    148.
 196.    398.    341.    181.    108.     76.     56.     46.     37
  28.     17.     10.      6.      4.      4.


 PEAK FLOW (IN CFS) = 400.  AT   2.80 HR    VOLUME (IN AC-FT) =  38.26

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Note: Unit Hydrograph is Optional Output. Lag-Time = Centroid of Rainfall to Peak Flow in Hours. C SUB T = Time to Peak in Unit Hydrograph in minutes for the Snyder Method (Not Used).